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B.S.C. *H.S.*
Attorney for Applicant

PATENTDocket No. SJ0920000145US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Tsann Lin et al.

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Serial No.: 10/040,061

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Filed: January 4, 2002

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For: SPIN-VALVE SENSOR WITH PINNING LAYERS
COMPRISING MULTIPLE ANTIFERROMAGNETIC
FILMS

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Examiner: Vivek D. Koppikar

DECLARATION UNDER 37 C.F.R. §1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Tsann Lin, declare as follows:

1. I am an employee of Hitachi Global Storage Technologies, Inc. (Hitachi).
2. I am a former employee of a department of IBM which has been sold to Hitachi.
3. I am familiar with the contents and subject matter of the above-identified patent application having Serial Number 10/040,061 presently owned by IBM.
4. I am a co-inventor with Daniele Mauri of the invention which is the subject of the above-identified patent application.

5. It is my understanding that Japanese Patent Number 11-175919 by Reiko Arai et al. (hereinafter "JP '919") has been cited in an Office Action by the U.S. Patent and Trademark Office.

6. I assert that the one of ordinary skill in the art, like myself, is unlikely to attempt using a first AFM film and second AFM film from the same Mn-based alloy to form the pinning layer without being taught to do so. While Mn-based alloys may be referred to in the JP '919 reference, there is no teaching or motivation that would lead one of skill in the art to specifically form a first AFM film and second AFM film from the same Mn-based alloy such as Pt-Mn or Ni-Mn.

7. I assert that the one of ordinary skill in the art, like myself, is unlikely to have the time or financial resources to experiment with forty-eight combinations for a first AFM film and a second AFM film for the pinning layer due to the high costs involved. I further assert that multiple failed experiment attempts would quickly end further experimentation without significant justification and/or resources to justify continuing the experiments.

I will briefly explain why these experiments failed and will fail. JP '919 specifically teaches a disordered-phase AFM film combined with an order-phase AFM film. The disordered-phase AFM film provides a smaller critical thickness (above which the AFM phenomenon appears), while the second order-phase AFM film provides a higher blocking temperature (above which the AFM phenomenon disappears). To attain these highly desired advantages, JP '919 insists on the combination of two films selected from two different alloy systems. However, experiments have confirmed that their non-compatible microstructures and magnetic-spin configurations still cause difficulties in ensuring the feasibility of this combination.

In the first case, as taught by JP '919, one may combine a disordered-phase Ir-Mn film and an order-phase Pt-Mn film. The Ir-Mn and Pt-Mn may have critical thicknesses of 7.5 and 20 nm, respectively, and have blocking temperatures of 270 and 360 °C, respectively. The Ir-Mn film exhibits a face-centered-cubic ($a = b = c = 0.3776 \text{ nm}$) microstructure, where Ir and Mn atoms are randomly located in corners and centers of six faces of each crystalline unit cell, and magnetic spins of Mn atoms are oriented in random orientations. A weak AFM phenomenon appears when such atoms are randomly packed

to form a disordered AFM phase with a thickness exceeding 7.5 nm. On the other hand, the Pt-Mn film exhibits a face-centered-tetragonal ($a = b = 0.3997$ nm and $c = 0.3703$ nm) microstructure, where only Mn atoms are located in the corners and centers of the top and bottom surfaces of each crystalline unit, and magnetic spins of corner and center Mn atoms are oriented in $[-1\ 0\ 0]$ and $[1\ 0\ 0]$ directions, respectively, while only Pt atoms are located in centers of four side faces of each crystalline unit cell. A strong AFM phenomenon appears when such atoms are regularly packed to form an ordered AFM phase with a thickness exceeding 20 nm. Due to these substantial differences in microstructures and magnetic-spin configurations, the combination of the two films results in no interaction, meaning the presence of one film does not affect the other film. Thus, the highly desired advantages of a critical thickness of 7.5 nm and a blocking temperatures of 360 °C cannot be attained. In fact, only the Ir-Mn film plays its original role, while the Pt-Mn film plays no role at all.

In a second case, not taught by JP '919, one may combine an ordered-phase Pt-Mn film and another order-phase Ni-Mn film. The Ni-Mn film has a critical thickness of 25 nm and a blocking temperature of 450 °C. The Ni-Mn film exhibits a face-centered-tetragonal ($a = b = 0.3697$ nm and $c = 0.3539$ nm) microstructure, where only Mn atoms are located in the corners and centers of the top and bottom surfaces of each crystalline unit, and magnetic spins of corner and center Mn atoms are oriented in $[0\ 0\ -1]$ and $[0\ 0\ 1]$ directions, respectively, while only Ni atoms are located in centers of four side faces of each crystalline unit cell. The Ni-Mn film shows strong AFM phenomenon when such atoms are regularly packed to form an ordered AFM phase with a thickness exceeding 25 nm. Due to the substantial differences in lattice parameters and magnetic-spin configurations, the combination of the two films results no interaction, meaning the presence of one film does not affect the other film. Thus, the highly desired advantages of a critical thickness of 20 nm and a blocking temperatures of 450 °C cannot be attained. In fact, only the Pt-Mn film plays its original role, while the Ni-Mn film plays no role at all.

In a third case, also not taught by JP '919, one may combine an ordered-phase Pt-Mn (or Ni-Mn) film with a Mn content ranging from 40 to 60 at%, and another ordered-phase Pt-Mn (or Ni-Mn) film with a Mn content below 40 at% or above 60 at%. In spite

of the same microstructures and comparable lattice parameters, the ordered-phase Pt-Mn (or Ni-Mn) film with a Mn content below 40 at% or above 60 at% exhibit no AFM phenomenon at all. Hence, the first Pt-Mn (or Ni-Mn) film plays its original role, while the second Pt-Mn (or Ni-Mn) film plays no role at all.

In our case, claimed in our disclosure, we combine two ordered-phase Pt-Mn (or Ni-Mn) films. It is well known that Pt-Mn (or Ni-Mn) films must be annealed to serve in the pinning layer. Therefore, the films are inherently of an ordered phase. In other words, the films exhibit a face-centered-tetragonal (FCT) microstructure. In the films, the Mn content ranges from 40 to 60 at%. In one film the Mn content is in the higher bound of this AFM composition range and in the other film the Mn content is in the lower bound of this composition range. As described in embodiments of this disclosure, the highly desired advantages can only be attained in this case. It should be noted that any small amount of other third atoms, even as small as oxygen or nitrogen atoms, can immediately interrupt the desired magnetic-spin configuration and completely destroy the AFM phenomenon. Therefore, it's very crucial that only binary Pt-Mn (or Ni-Mn) films are used such that the highly desired advantages are attained.

8. I assert that it is crucial that the first AFM film and second AFM film be from the same Mn-based alloy such that the crystalline lattices of the first and second films will align. Such alignment contributes to beneficial characteristics such as a high blocking temperature, maximum corrosion resistance, and optimal exchange coupling.

9. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful, false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated this 15 day of January 2004.


Tsann Lin